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Productivity Improvement By Cycle Time Reduction Using Time And Motion Study A-Case Study Of Electrode Manufacturing Company

Pankaj Bhagat[1] and F. Ujjainwala[2]
[1]Pg Scholar, IPE Dept, SGSITS Indore
Asst. Professor, IPE Dept.
SGSITS,Indore
Email: [1] Pankajbhagat83@Gmail.Com
Email: [2]Fujjain@Gmail.Com

Abstract
The systematic application of time study, and method study to improve productivity, reduce cost and improve profit. The productivity can be improved by reduction in cycle time. The Cycle time can be defined as the time required completing any process. Work study is the scientific research involving work techniques with the objective of identifying the best way of doing a work. Time study is used to eliminate the Ineffective time while operation is being performed. This study performs a work study analysis at the product finishing shop of with the aim to offer suggestions to improve its operational and production efficiency. Primary data was collected in PFS shop of Electrode machining process, through observation method (time study sheet using stop watch). Afterward it concludes the summarized data by various charts and time study sheet.

Keywords: *work study, time study, method study, cycle time, productivity, idle time, non value added time.*

INTRODUCTION

The world is constantly changing. In this changing world, the industries are willing to retain the customer and provide the product the right time, with right quality and quantity. The roles and responsibilities of the industries are converging toward the customer in order to be the global player.

Frederick W. Taylor is considered as the "Father of Modern Industrial Engineering. He put forth his ideas on "scientific management" and "Work measurement" in 1881. In 1885, Frank B. Gilbreth introduces "Motion Study" and constructs the process chart. He defines motion study as the science of eliminating wistful result from unnecessary, ill direction and inefficient motion.

The time and motion study tool for reduction of unwanted process and identify the non value added activity it's also help improvement of productivity.

The company has six shops in the plant. The product finishing shop (PFS) is the last shop of the company. Where work performed is finishing and machining of electrode. Company used three machines namely facing, centering, and threading machine, and final assembly of electrode with nipple, The nipple used to join of two electrode, a nipple machining by fully automatic CNC machine. But electrode machining used to semiautomatic machine. This study was focused on productivity improvement of electrode machine chain. Company used heavy electric crane for material movement, the electric crane operated by two operators with wireless remote control,
The electrode manufacturing company final output product is ultra high power

electrode. This electrode using iron processing industries for malting iron ores and also using nuclear power plant.

Productivity

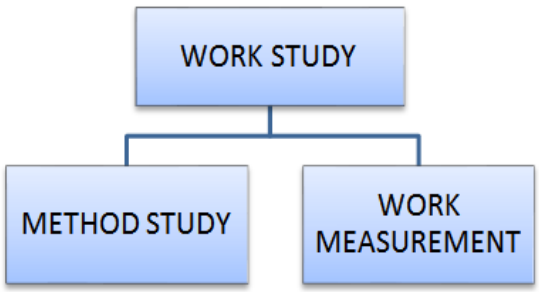
The productivity of any organization is cost effective activity. The principal aim of work study is to increase productivity. The productivity of any production system is a better use of recourses and more efficiency of the machine. The work study is an intelligent application for increase productivity its can produce more product at a same available working time so as cost of per product reduced and increasing purchasing power of consumer in,

Work Study

"Work study is the systematic examination of the methods of carrying on activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out."(ILO 2014)

The term "work study" embraces several techniques, but in particular method study and work measurement.

The aim of work study is to examine all the activity and process to running by man or machine. Its gives a simple and effective method and its can modify when any operation has unnecessary or excess work. Reducing in wasteful work through work study to better use of resources and set up a time, standard for a process that activity.



Method Study- Method study is the systematic recording and critical examination of ways of doing things in order to make improvements. It is use to therefore, company earn more profit and increase living standard of people.

Productivity is the ratio of aggregate output to aggregate input; the output may be any product or service and input like a natural resources land, building, raw material or machine, equipment.

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

The enterprise using to certain resources or inputs with which it produces the desired output. These are:

1. Land and Buildings, 2.Material, 3.Energy. 4.Machines and Equipment, 5 Manpower

simplify the way to accomplish a work and to improve the method of production it employs a systematic approach involving:

Select – Record – Examine – Develop – install – maintain.

Work Measurement- Work measurement study is a general term used to describe the systematic application of industrial engineering technique to establish the work content and time it should take to complete the task or series of task. There are many techniques to use work measurement, the stop watch one of the best method because it is simple to use and effective.

Work Content "Work content means, of course, the amount of work contained in a given product or a process measured in work-hours or machine hours" (ILO 2014)

The work hour for the labor is one person take one hour

The machine hour for the running machine is a piece of the plant for one hour.

Cycle Time Calculation

Each event was broken down in to element and the observed reading of each element was noted with its description. Observed reading was taken in minutes and second by stopwatch.

Element taken to account are: loading, unloading, machining, material movement,

air cleaning, inspection, worker movement observe activity such as on line inspection, and data entry on computer etc. Take 10 observations of each activity at seconds and the average time in minutes was calculated.

Types of Charts Used in Method Study

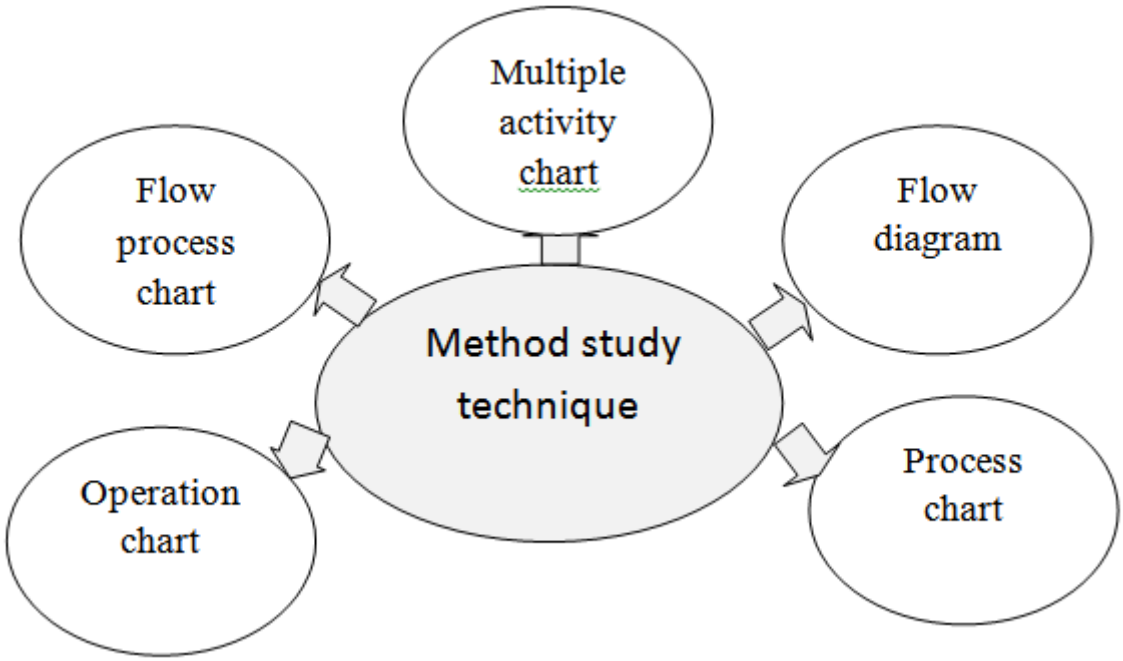


Fig 1.5 *Types of charts used in method study*

Product of Company (Electrode)

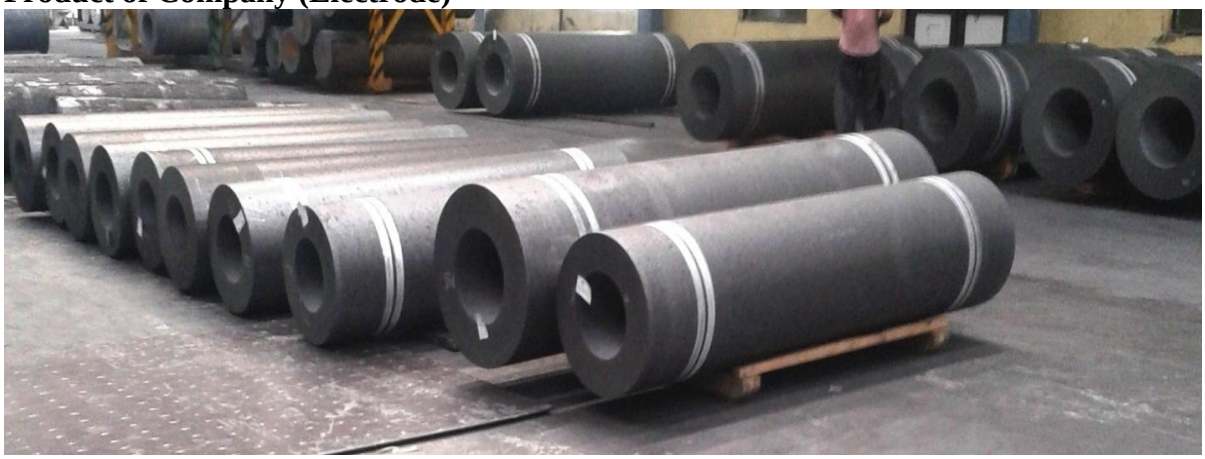


Fig: *Finished Product in PFS Shop(Graphite Electrode)*

Problem Formulation

The product finishing shop have three machines and machines installed in line layout, the row material start flow from input conveyer and passed through centering, facing, turning and last threading, and last go for inspection in outlet conveyer. The machining process performed by to operator with using three crane namely C1, C2, C3.

1. There are many problem in current layout, the perform operation with three cranes between two operators is some time interference each other and waiting while first operated carry crane. It results increase the cycle time

and more idle time for man and also machine.
2. The threading machine cycle time is more than other two machines its causes increase waiting time of other two machines.

RESEARCH OBJECTIVES

The main objective of project

1. Productivity improvement by reducing cycle time.
2. Calculate the standard time of every manual work.
3. Elimination of non-value added time on the process
4. Reduce the operator idle time for better use of man machine system.

METHODOLOGY

1. Understand the current working procedure and entire material flow process from input (raw material) to output (finished product).
2. Construct Man and Machine type flow process chart of two operators.
3. Prepare time study observation sheet, elemental time data has been collected by the cumulative method of stop watch.
4. Then observed time data has been converted to basic time by multiplying with the rating factor of worker.

a. Basic time = observed time x (rating/ standard time)

5. Calculation for standard time to added basic time with allowances which given the
6. company for workers.

a. Standard time = Basic time + Allowance(% of basic time)

7. vi. Construct the multiple activity charts and calculate the idle time for man and machine.
8. Implement of flow process chart to reduction in Idle time non value added time.

Data Collection All the process and cycle time of man and machine are calculated by true data collection. The data collection is the initial process of any improvement and help to decide solution of problem. The data collection is methodological study of past for arriving at conclusion for work study. Taken observation to time study by stop watch in all process of machining. Construct the current man type flow process chart to first and second operator of all the machining process.

Layout of Product Finishing Shop and Flow of Material

In this layout of machining shop, material flow from right side to left side. The product flow from input conveyor via 3 machines to inspection conveyor. For using product flow using 3 electric crane machine. The operation performed by two operators. Job assign to first operator perform on centering and turning machine, and job assign to second operator on threading and doing inspection.

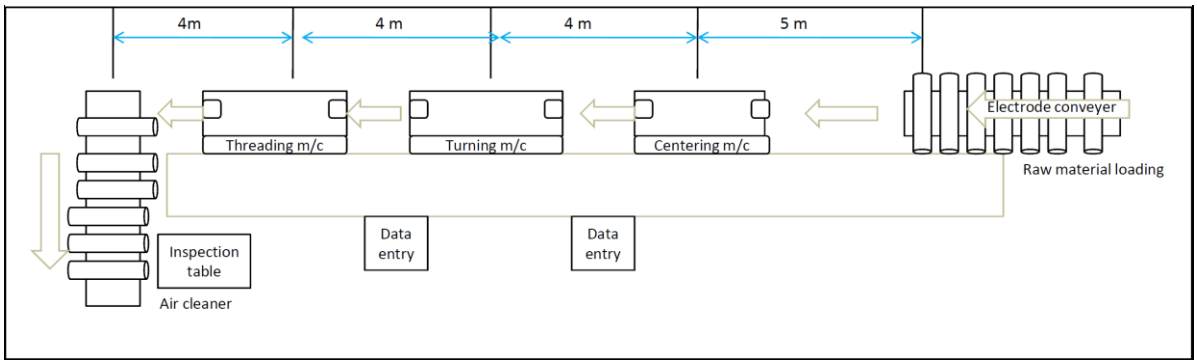


Fig: *Plant layout of Product Finishing Shop*

Table: *Prepare time study sheet to every work element (Total no of sheet made 10)*

1	Product: Electrode	Time study sheet										Date : 27/06/16
	Operation: loading and turning machine											
	Section: PFS Shop											Operator: 1
S.No	Element Description	Cycle time in seconds										Average time in second
		1	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***	
1	operator move crane (C1) for loading on turning machine	7	6	4	7	6	8	5	6	5	4	**5.8**
2	crane move down side with electrode	8	10	8	7	8	9	8	7	9	8	**8.2**
3	electrode loading on turning m/c	17	14	16	16	14	15	14	14	16	15	**15.1**
4	belt open over the electrode	5	6	5	6	6	6	7	7	5	6	**5.9**
5	crane (C1) move up side and hold	4	6	5	3	4	3	4	5	3	5	**4.2**
6	operator give command for turning	4	3	2	3	3	4	3	3	3	2	**3**
7	turning operation cycle time	285	285	285	285	285	285	285	285	285	285	**285**
Total time		**330**	**330**	**325**	**327**	**326**	**330**	**326**	**327**	**326**	**325**	**327.2**

Flow process chart for first operator

Man type process chart (before improvement)								
Process: centering and turning Product: Electrode			11			1		
Operator: 1			12			2		
Observer: pankaj bhagat Charted On: 26/26/16			1	Operator idle time		159		
S. No.	Activity	Time	transport	operation	inspection	delay	storage	
1	operator move crane (C1) for loading on turning machine	5.8						
2	crane move down side with electrode	8.2						
3	electrode loading on turning m/c	15.1						
4	belt open over the electrode	5.9						
5	crane move up side and hold the electrode	4.2						
6	operator give command for machining	3						
7	turning operation cycle time	284						
8	operator carry crane (C1) to product input conveyer	28.2						
9	crane belt down for pickup of electrode	9.8						
10	setting time crane belt on electrode	8.9						
11	crane belt pickup and move up with electrode	8.1						
12	crane (C1) travel toward centering m/c	15.2						
13	crane move down side with electrode	8.3						
14	loading on centering m/c	11						
15	operator give command for machining	3.1						
16	centering operation cycle time	50						
17	unloading from m/c	7.8						
18	crane (C1) move up side with electrode	6.8						
19	crane (C1) travel with electrode toward turning m/c and hold	18.2						
20	operator waiting for turning process	105						
21	after complete turning start inspection	20.2						
22	data entry and marking	9.9						
23	crane (C2) belt setting on electrode	7.2						
24	unloading of electrode from m/c	8.9						
25	crane(C2) move up side with electrode	8.2						
26	crane (C2) travel with electrode toward threading m/c	23.3						
27	hold the electrode near the threading m/c	2.1						
total time		686.4						

Flow process chart for second operator

Man type process chart for operator 2 (before improvement)						
Process: threading and inspection Product: Electrode			10			1
operator: 2			14			4
Observer: Pankaj bhagat Charted On: 26/26/16			1		Idle time	123
Sr. No.	Activity	Time	transport	operation	inspection	delay	storage
1	operator move the crane for loading on threading machine	6.1					
2	crane move down side with electrode	8.1					
3	electrode loading on threading m/c	14.8					
4	crane (C2) belt open over the electrode	5.6					
5	operator move crane (2) upside and hold	5.3					
6	operator give command for machining	3					
7	threading machine cycle time	286					
8	crane (C2) travel toward turning machine	7.9					
9	crane (C2) hold near of turning machine	2.1					
10	operator walk toward outlet conveyer	10					
11	operator move crane (C3) down side for leave the electrode on outlet conveyer	9.1					
12	operator open crane belt over electrode	4.7					
13	crane (C3) move up side	4.9					
14	crane (C3) move toward threading m/c	10.3					
15	hold the crane(3) near the threading m/c	2.2					
16	operator walk toward outlet conveyer	8.9					
17	pick up air gun for cleaning of thread	6					
18	thread cleaning by air	10.2					
19	put off the air gun	6.1					
20	pick up the thread measuring instrument	10.9					
21	inspection time	41.8					
22	put the instrument on table	10.2					
23	data entry on computer	10.9					
24	operator walk toward threading m/c	5.1					
25	operator waiting for machining	123					
26	crane (C3) belt setting on electrode	4.9					
27	unloading of electrode from m/c	5.8					
28	crane (C3) move up side with electrode	8.2					
29	crane (C3) travel toward outlet conveyer	25.2					
30	hold the crane(3) near the outlet conveyer	2.2					
	Total time	659.5					

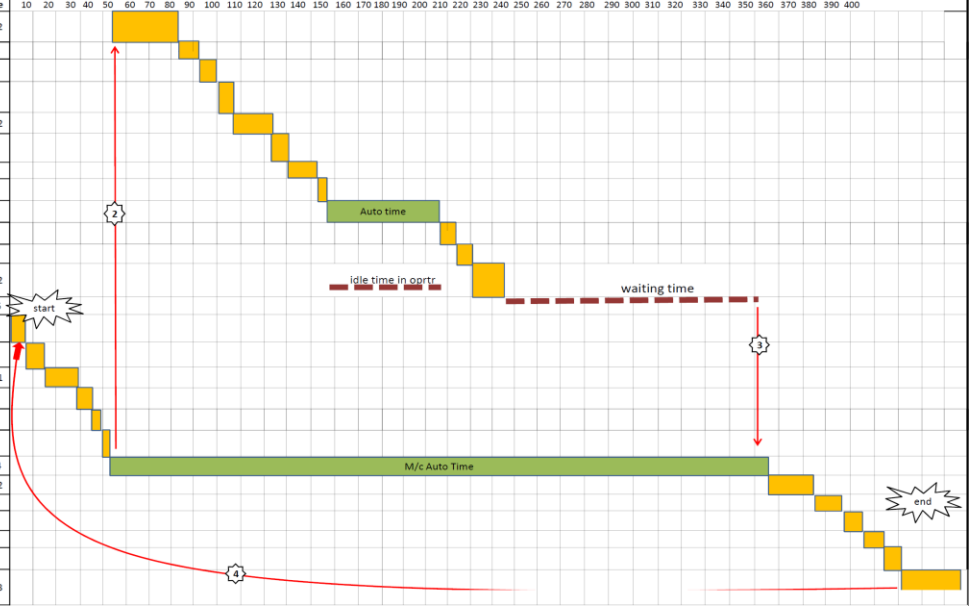
Constricting Multiple Activity Chart for Both Operator

Multiple activity chart for operator 1 (Before improvement)

Operation: Electrode centering and turning — Cycle time of operation: 405 second

Number of operator: 1 — Number of crane for transport of electrode: C1,C2

Sr. No.	Activity	Avrg time
1	operator carry crane (C1) toward product input conveyer	28.2
2	crane belt down for pickup of electrode	9.8
3	setting time crane belt on electrode	8.9
4	crane belt pickup and move up with electrode	8.1
5	crane (C1) travel toward centering m/c	15.2
6	crane move down side with electrode	8.3
7	loading on centering m/c	11
8	operator give command for machining	3.1
9	centering operation cycle time	50
10	unloading from m/c	7.8
11	crane (C1) move up side with electrode	6.8
12	crane (C1) travel with electrode toward turning m/c and hold	18.2
13	waiting time	105
14	operator move crane (C1) for loading on turning machine	5.8
15	crane move down side with electrode	8.2
16	electrode loading on turning m/c	15.1
17	belt open over the electrode	5.9
18	crane (C1) move up side and hold	4.2
19	operator give command for turning	3
20	turning operation cycle time	284
21	inspection	20.2
22	data entry and marking	9.9
23	crane (C2) belt setting on electrode	7.2
24	unloading of electrode	8.9
25	crane(C2) move up side with electrode	8.2
26	crane (C2) travel with electrode toward	25.3

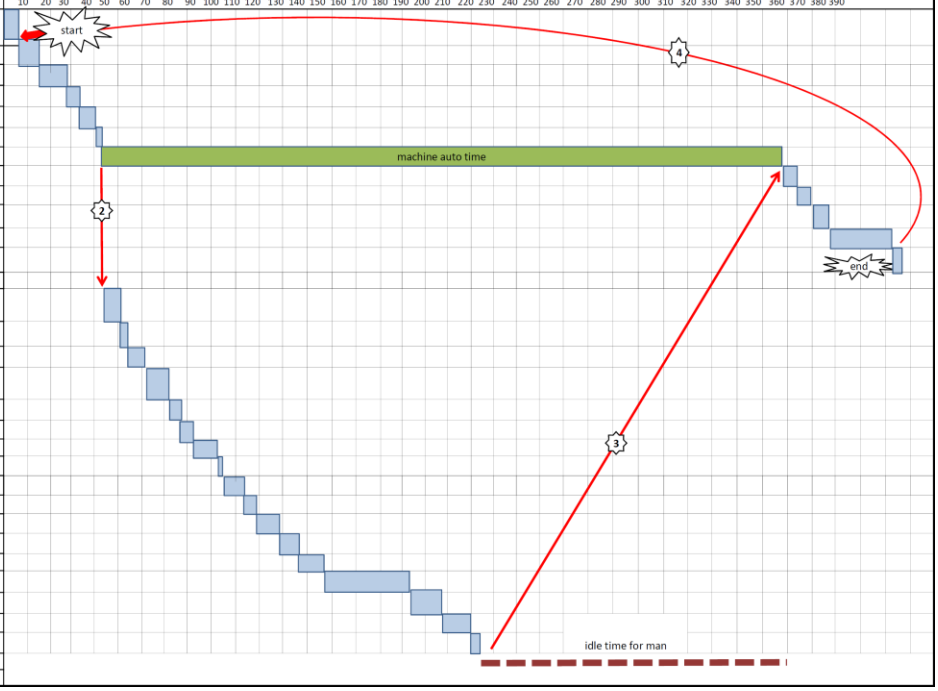


Multiple activity chart for operator 2 (before improvement)

Operation: Electrode threading and inspection | Cycle time of operation: 375 second

Number of operator:1

Sr. No.	Activity	avrg time
1	operator move the crane (2) for loading of electrode on threading machine	6.1
2	crane move down side for loading	8.1
3	electrode loading on threading m/c	14.8
4	crane (C2) belt open over the electrode	5.6
5	operator move crane (C2) upside	5.3
6	operator give command for machining	3
7	threading machine cycle time	286
8	crane (C3) belt setting on electrode	4.9
9	unloading of electrode from m/c	5.8
10	crane (C3) move up side with electrode	8.2
11	crane (C3) travel toward outlet conveyer	25.2
12	hold the crane(3) near the outlet conveyer	2.2
13	operator moving crane (C2) toward turning machine	7.9
14	crane (C2) hold near of turning machine	2.1
15	operator walk toward outlet conveyer	10
16	crane (C3) move down side for leave the electrode on outlet conveyer	9.1
17	crane belt open over the electrode	4.7
18	crane belt move up side	4.9
19	crane (C3) move toward threading m/c	10.3
20	hold the crane3 near the threading m/c	2.2
21	operator walk toward outlet conveyer	8.9
22	pick up air gun for cleaning of thread	6
23	thread cleaning by air	10.2
24	put off the air gun	6.1
25	pick up the thread measuring instrument	10.9
26	inspection time	41.8
27	put the instrument on table	10.2
28	data entry on computer	10.9
29	operator walk toward threading m/c	5.1
30	waiting time	123
	Total time	659.5



RESULTS

From the above various charts it can be concluded that the process can be improved based on method study, work procedure and proper utilization of man machine. The machining cycle time will be reducing from 405 (6.75 minutes) seconds to 345 (5.75minutes) second per electrode the company saved 60 second (1 minute). The percentage improvement of productivity of the system is 18.9 %. The proposed system can reduction in idle time for man and machine system and work performed in a systematic manner respectively.

Table: *Cycle time reduction for first and second operator*

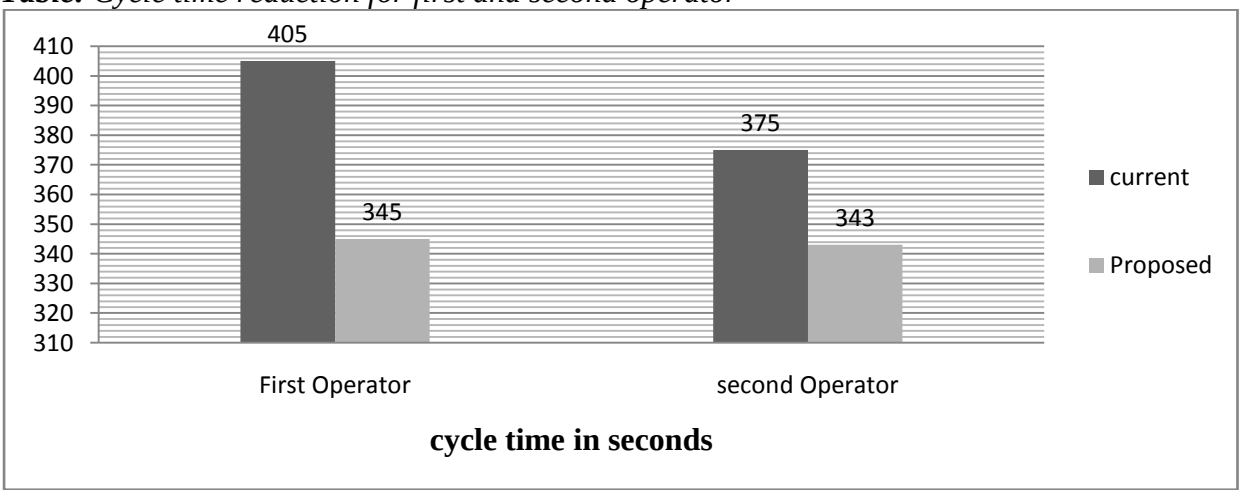
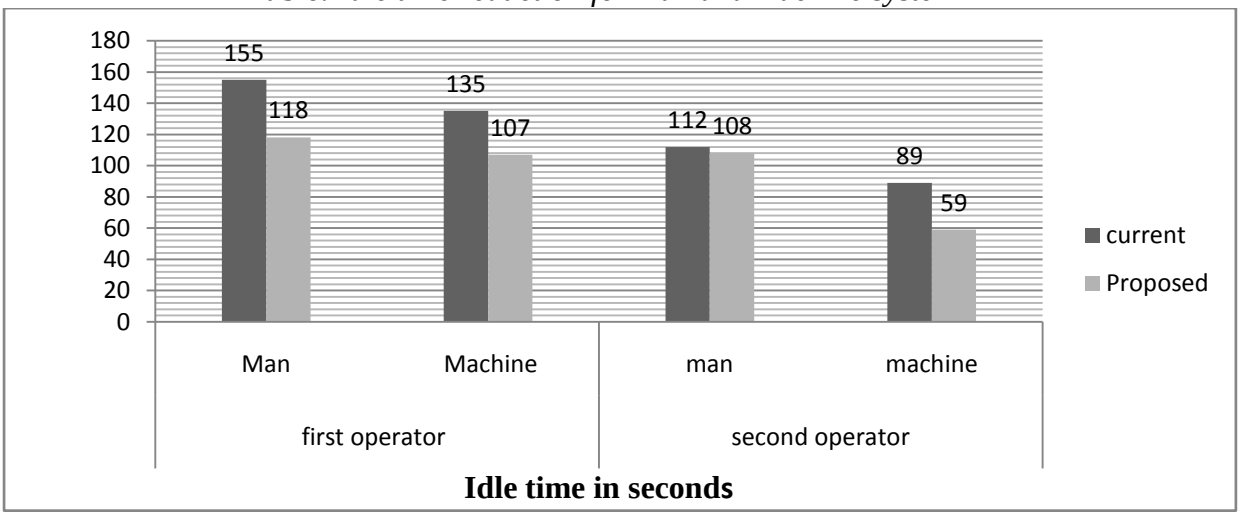


Table: *Idle time reduction for man and machine system*



CONCLUSION

The time and motion study is effective tools of industrial engineering to give a standard time to perform any process at minimum time. the flow process and multiple activity chart help easy to understand performing method and easy to calculate idle time for man and machine system. The cycle time reduction through eliminate unproductive activity. Its result is increase productivity of the system.

Future Scope

When preferring paper select some of tools and technique for future work like Work study techniques are quite expensive to implement in a small scale industries but this method gives better results than any other technique. These techniques can be useful not only to reduce the cycle time but also in various other departments in industries like inventory control, productivity, quality , labor work, at various machines in machine shop to get process variation etc.

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